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EXAMINER

NGUYEN, HA T

ART UNIT

PAPER NUMBER

2812

DATE MAILED: 03/07/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

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## Office Action Summary

**Application No.**

09/739,620

**Applicant(s)**

ODA, NORIAKI

**Examiner**

Ha T. Nguyen

**Art Unit**

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☒ Responsive to communication(s) filed on 26 December 2001.
- 2a) ☐ This action is **FINAL**.                      2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims

- 4) ☒ Claim(s) 1-25 is/are pending in the application.
- 4a) Of the above claim(s) 12-24 is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-3, 7-11 and 25 is/are rejected.
- 7) ☒ Claim(s) 4-6 is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on \_\_\_\_\_ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

### Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All   b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

### Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) \_\_\_\_\_
- 4) ☐ Interview Summary (PTO-413) Paper No(s). \_\_\_\_\_
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: \_\_\_\_\_

## **DETAILED ACTION**

### ***Notice to applicant***

1. Applicants' Amendment and Response to the Office Action mailed 9-26-01 has been entered and made of record (Paper No. 8).

### ***Response to Amendment***

2. In view of applicants' arguments and the amendment to the claims, the objection of claims 1-11 for informalities and the rejections of claims 4, 5, and 11 under 35 U.S.C. 112 second paragraph, as being indefinite, have been withdrawn.

In view of applicants' argument, the rejection of claims 4-6 , under 103 has been withdrawn.

3. Applicants' arguments with regard to the rejections under 35 U.S.C. 102 or 103 have been fully considered, but they are not deemed to be persuasive for at least the following reasons.

Applicants argued that Geffken et al., US Patent 5985762 (hereinafter Geffken) does not disclose "covering an outer surface of the conductor" with "refractory metal nitride" as recited in claim 1, in Fig. 3D Geffken only shows that the layer 29 is below the copper 30. The examiner disagrees, referring to the instant Fig. 1 and the page 13, lines 21-23 of the specification, the "entire outer surface of the conductor 5 is covered with and contacted with the refractory metal nitride cover layer 4", the entire outer surface of the conductor 5 shown in Fig. 1 comprises the top, the bottom, and the side surfaces of the conductor layer 5. These surfaces are more expressly disclosed in page 17, lines 11-16. With this interpretation of the outer surface of the conductor , Geffken anticipates claim 1, even though layer 29 does not cover the top surface of the conductor, since the claim does not require the cover layer to cover the entire outer surface of the conductor layer. For the same reason, the combined teaching of Geffken and Nogami et al., US Patent 6214731 (hereinafter Nogami) does teach all the limitation of claim 11.

Applicants argued that Farkas et al. , US Patent 6001730 (hereinafter Farkas) does not teach the use of a multiple cover layers made of alternative combinations of refractory metal nitride, refractory metal, and dielectric as recited in claims 3-8, only a single barrier layer 21 is disclosed. The examiner disagrees, Farkas discloses that the barrier layer 21 can be "one or more

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of tantalum, tantalum nitride (TaN), tantalum silicon nitride (TaSiN), composites thereof or the like in a preferred form" (see col. 4, lines 49-58). In the situation where the barrier layer 21 formed of a TaN layer and a Ta layer ( TaN/Ta composite diffusion barrier layer) replacing the layer 29 of Geffken, all the limitations of claim 3 are met. Therefore, the combined teaching of Geffken and Farkas does teach all the limitations of claim 3.

Applicants are referred to the new ground of rejection given below.

***Claim Rejections - 35 USC § 102***

4. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless --

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

(e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371<sup>9</sup> of this title before the invention thereof by the applicant for patent.

5. Claims 1 and 2 are rejected under 35 U.S.C. 102(b) as being anticipated by Geffken.

As to claim 1, referring to fig. 3D, Geffken discloses a semiconductor device comprising: a substrate 21 having a surface; a dielectric 23 formed over the surface of the substrate; and a wiring line buried in the dielectric layer; the wiring line including a Cu-based conductor 30 and first cover layer 29 covering an outer surface of the conductor; the first cover layer being made of refractory metal nitride (see col. 3, lines 35-39). Note that the examiner interprets the outer surface of the conductor to be the surface surrounding the conductor.

As to claim 2, Geffken discloses wherein the first cover layer is made of nitride of at least one selected from the group consisting of Ti , Ta and W(see col. 3, lines 35-39).

6. Claims 1, 2, 9, and 25 are rejected under 35 U.S.C. 102(e) as being anticipated by Lee, U. S. Patent 6171960.

[Claim 1] Referring to fig. 1D, Lee discloses a semiconductor device comprising: a substrate 100 having a surface; a dielectric 104 formed over the surface of the substrate; and a wiring line 106-112 buried in the dielectric layer; the wiring line including a Cu-based conductor 110 and first cover layer 108 covering an outer surface of the conductor; the first cover layer being made of refractory metal nitride (see col. 1, lines 34-59);

[Claim 2] wherein the first cover layer is made of nitride of at least one selected from the group consisting of Ti, Ta and W (see col. 1, lines 34-59);

[Claim 9] wherein the wiring line has a damascene structure (see col. 1, lines 34-59);

[Claim 25] wherein the first cover layer entirely covers the outer surface of the conductor. Note that the examiner interprets the outer surface of the conductor to be the surface surrounding the conductor.

7. Claims 1, 2, and 25 are rejected under 35 U.S.C. 102(e) as being anticipated by Mori et al., US Patent 6303495 (hereinafter Mori).

[Claims 1 and 25] Referring to fig. 9, Mori discloses a semiconductor device comprising: a substrate 10 having a surface; a dielectric 18a,b formed over the surface of the substrate; and a wiring line 19a, 20a buried in the dielectric layer; the wiring line including a Cu-based conductor 20a and first cover layer 19a covering an entire outer surface of the conductor; the first cover layer being made of refractory metal nitride (see col. 7, lines 32-60);

[Claim 2] wherein the first cover layer is made of nitride of at least one selected from the group consisting of Ti, Ta and W (see col. 7, lines 32-60).

### ***Claim Rejections - 35 USC § 103***

8. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

9. Claim 3 is rejected under 35 U.S.C. 103(a) as being unpatentable over Geffken, in view of Farkas or Schmidbauer et al., US Patent 6221757 (Schmidbauer) .

Geffken discloses substantially the limitations of claim 3, as shown above.

But it does not disclose expressly a second cover layer provide between the conductor and the first cover layer; wherein the second cover layer covers entirely or partially the outer surface of the conductor, the second cover layer being made of refractory metal.

However, the missing limitations are well known in the art because Farkas discloses a diffusion layer for Cu which could be a combination of layers of Ta, TaN, TaSiN...etc (See col. 4, lines 48-58) when Farkas combination of layers as diffusion barrier (for example TaN/Ta) is used in Geffken, the limitations of claim 3 are met. Schmidbauer discloses the use of TiN/Ta barrier layer for copper (see Fig. 4 and col. 4, lines 7-23).

A person of ordinary skill is motivated to modify Geffken with Farkas or Schmidbauer for better protection against diffusion of Cu .

Therefore, it would have been obvious to combine Geffken with Farkas or Schmidbauer to obtain the invention as specified in claim 3.

10. Claims 7 and 8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Geffken.

Geffken discloses wherein the dielectric formed over the surface of the substrate is made of inorganic material or organic material having a low relative dielectric constant (see col. 3, lines 5-10).

But it does not disclose expressly the values of the relative dielectric constant of the inorganic or organic materials used.

However, since Geffken discloses some of the same materials specified by the instant specification for example fluorinate silicate ( $\text{SiOxFy}$ ), polymeric material, the material used must have dielectric constant within or in the neighborhood of the claimed relative dielectric constant.

Therefore, it would have been obvious to use Geffken's teaching to obtain the invention as specified in claims 7 and 8 .

11. Claim 10 is rejected under 35 U.S.C. 103(a) as being unpatentable over Mori, as applied to claims 1, 2, and 25 above, and in view of Li et al., U.S. Patent 6040243 (Hereinafter Li).

Mori discloses substantially the limitations of claim 10, as shown above. It also discloses wherein the dielectric in which the wiring line is buried has a composite structure comprising a first dielectric layer and a second dielectric layer formed on the first dielectric layer and wherein the bottom of the first cover layer is approximately in a same level as an upper surface of the first dielectric layer and the top of the first cover layer is approximately in the same level as an upper surface of the second dielectric layer.

But it does not disclose an etch stop layer formed between the first and second dielectric layers.

However, it is well known in the art because Li discloses this feature (see fig. 8 where the etch stop layer 72 is between the first dielectric layer 62, and the second dielectric layer 76, 80, 84 and 88).

A person of ordinary skill is motivated to modify Geffken with Li to obtain well controlled etching.

Therefore, it would have been obvious to combine Geffken with Li to obtain the invention as specified in claim 10.

12. Claim 11 is rejected under 35 U.S.C. 103(a) as being unpatentable over Geffken, Mori or Lee in view of Nogami et al., U.S. Patent 6214731 (Hereinafter Nogami).

Geffken discloses substantially the limitations of claim 10, as shown above.

But it does not disclose expressly a via hole of tapered shape with the claimed slope.

However, it is well known in the art because Nogami discloses this feature (See fig. 1A ).

A person of ordinary skill is motivated to modify Geffken, Mori or Lee with Nogami to obtain better filling of the contact hole.

Therefore, it would have been obvious to combine Geffken, Mori or Lee with Nogami to obtain the invention as specified in claim 11.

*Allowable Subject Matter*

13. Claims 4-6 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Claims 4 and 6 recites the use of a third cover layer between the conductor and the first cover layer; wherein the third cover layer covers entirely or partially the outer surface of the conductor, the cover layer being made of dielectric.

These features in combination with the other elements of the claims are neither disclosed nor suggested by the prior art of record.

Claim 5 variously depends from claim 4, it is allowed for the same reason.

*Conclusion*

14. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ha Nguyen whose telephone number is (703)308-2706 . The examiner can normally be reached on Monday-Friday from 8:30AM to 5:00PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, John Neibling, can be reached on (703) 308-3325. The fax phone number for this Group is (703) 308-7722.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 308-0956.

Primary Examiner



Ha Nguyen  
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